Chair for Algebraic and Logical
Foundations of Computer Science
TU Dresden

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Logic Programming Engineering – Assignment 2

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Exercise 2.1 [Simple cut prediction]

Consider the following program.

```
p(1).
p(2) :- !.
p(3).
```

What will be the result of the following queries? Please fill the table by first writing down your predicted answer and then the actual answer when typing the commands into SWI-Prolog. Compare the results and find explanations whenever the outcome differs from what your prediction was.

query	predicted answer	Prologs' answer

`p(X).`
`p(X), p(Y).`
`p(X), !, p(Y).`		

Exercise 2.2 [Cut prediction]

Consider the following Prolog program and **predict** the output to the queries below.

```
top(X,Y) :- predicate(X,Y).
top(X,X) :- symmetric(X).

predicate(X,Y) :- cutPoint(1), val4X(X), cutPoint(2), val4Y(Y), cutPoint(3).
predicate(X,Y) :- symmetric(X), val4Y(Y).

val4X(a).
val4X(b).

val4Y(c).
val4Y(d).

symmetric(e).

cutPoint(_).
```

a) Enumerate all answers to the queries `predicate(X,Y)` and `top(X,Y)`.

b) What changes if `cutPoint(1)` is replaced with a cut?

c) What changes if `cutPoint(2)` only is replaced with a cut?

d) What are all answers to the queries `predicate(X,Y)` and `top(X,Y)` if both `cutPoint(1)` and `cutPoint(2)` are replaced with a cut?

e) What if only `cutPoint(3)` is replaced with a cut?

Exercise 2.3 [Fibonacci numbers]

a) Write a Prolog predicate `fibonacci/2` to compute the n-th Fibonacci number. The Fibonacci sequence is defined as follows: $F_0 = 1$, $F_1 = 2$, and $F_n = F_{n-1} + F_{n-2}$ for $n \geqslant 2$.

Example:

```
?- fibonacci(4, X).
X = 8.
```

b) Provide a predicate `fibonacci/4` that computes the n-th Fibonacci number assuming that $F_0 = x_0$ and $F_1 = x_1$, where x_0, x_1 are given as parameters, i.e, $F_0 = x_0$, $F_1 = x_1$, and $F_n = F_{n-1} + F_{n-2}$ for $n \geqslant 2$. The predicate should have the format: `fibonacci(N,X1,X2,FN)`. Rebase your predicate `fibonacci/2` on `fibonacci/4`.

Examples:

```
?- fibonacci(4, 1, 2, X).
X = 8.
```

```
?- fibonacci(4, 2, 4, X).
X = 16.
```

c) Find a solution to the following problem[1]: by considering the terms in the Fibonacci sequence whose values do not exceed a certain bound B, what is the sum of the even-valued terms? E.g., if $B = 10$ then, as $F_5 = 13 > B$, only $F_1 = 2$ and $F_4 = 8$ are being summed and the result will be 10. Provide a predicate `fibsum/2` that computes the sum for a given bound. What is the sum if the bound is 4 million?

Example:

```
?- fibsum(10,Sum).
Sum = 10.
```

```
?- fibsum(1000, Sum).
Sum = 798.
```

d) Find a solution to the following problem[2]: the 10th Fibonacci number $F_{10} = 144$ is the first term to contain three digits. Provide a predicate `fibdigits/2` that returns the first term in the Fibonacci sequence that has $n \in \mathbb{N}$ digits. What is the first term in the Fibonacci sequence to contain 1000 digits?

Examples:

```
?- fibdigits(3,X).
X = 144.
```

```
?- fibdigits(10,X).
X = 1134903170.
```

[1] `https://projecteuler.net/problem=2`
[2] `https://projecteuler.net/problem=25`